DSN Scheduling System

R. Durham

Control Center Operations

The Deep Space Network (DSN) Scheduling Group provides the operationally oriented administrative support necessary for the effective scheduling of the DSN. The scheduling system plus the levels of schedules will be explained in this article.

I. Introduction

The DSN Scheduling Group, assigned to the Control Center Operations Section, has the direct responsibility and authority for scheduling Network operational resources based upon allocations, constraints and guidelines as set forth by the National Aeronautics and Space Administration, the Office of Space Tracking and Data Systems, and the Telecommunications and Data Acquisition and Deep Space Network Management.

Effective utilization of Deep Space Network (DSN) resources depends upon the requirements and plans of all users being known far enough in advance to accomplish orderly planning. DSN Scheduling provides the users of the Network with the accumulated requirements in a logical and timely manner.

The accomplishment of this task requires the ability to forecast gross requirements for a minimum of three years by means of the DSN Forecast (Fig. 1), refine these requirements into a three-month schedule by means of the DSS Utilization Plan, and further refine these activities in an eight-week schedule (DSN 8-Week Operations Planning Schedule), thereby

resulting in a detailed conflict-free weekly schedule (DSN 7-Day Operations Schedule). Figure 2 is a functional flow chart for scheduling and depicts the sequence of events.

Resource allocation is accomplished through a scheduling system comprising three levels of schedules; long-, mid- and short-range.

II. Long-Range Resource Allocation Schedule

The DSN Forecast, published quarterly, represents the combined resource requirements by the various network users for the upcoming three years. It also depicts one year of history comparing project requirements versus actual support provided. As the time approaches three months prior to the planned event, these requirements must be shown in greater detail. Whereas the DSN Forecast depicts Network user requirements in four-week increments by longitude and size of antenna, these requirements must now be delineated as to day and facility. This is accomplished via the DSS Utilization Plan, which is commonly referred to as the X-Chart, and the DSN/FPSO Conflict Resolution Operations Planning Schedule.

III. DSN/FPSO Conflict Resolution Operations Planning Schedule

Multiple users independently submitting requests for tracking resources twenty-four hours a day, seven days a week, creates an environment that can result in scheduling concurrent activities at the same facility. A joint DSN/Flight Project Support Office (FPSO) Scheduling Board is convened weekly to resolve these conflicts. The board comprises a representative from FPSO, DSN, each flight project, and other users of DSN Resources, as required. DSN Scheduling publishes a weekly DSN and FPSO Conflict Resolution-Operations Planning Schedule. The objective of this publication is to identify these conflicts as far in advance as possible. The following information is provided:

- (1) A list of user codes that are used to identify each user. These codes ensure the consistency and uniformity that is essential in data manipulation (Table 1).
- (2) A station loading table (Table 2). Each station requires a minimum of twenty hours per week for preventive maintenance. These tables enable scheduling personnel to ascertain if adequate maintenance has been allocated and if there is any remaining time available.
- (3) A DSS Utilization Plan or X-Chart (Table 3). This plan outlines by month and day the prime activities that are scheduled at each station. It does not reflect noninterference-basis activities or maintenance not requiring facility downtime.
- (4) A DSS Delta X-Chart (Table 4). This chart reflects additions or deletions occurring to the Scheduling data base as compared to the last issue of the DSN and FPSO Conflict Resolution-Operations Planning Schedule.
- (5) A Data Base listing that is month, day, and time sensitive, listing each activity at each station (Table 5) with identified conflicts.

IV. Mid-Range Resource Allocation Schedule

The X-Chart and the DSN/FPSO Conflict Resolution Planning Schedule have proven to be excellent vehicles for spanning the gross requirements outlined in the DSN Forecast and the refined requirements listed in the DSN 8-Week Operations Planning Schedule. The X-Chart depicts each activity by day and facility. Changes made to the X-Charts have varying degrees of impact on the users. The closer they are made to the scheduled event, the greater the impact on the facilities and projects with low priorities. The impact upon the facilities prohibits proper internal activity planning for personnel train-

ing, engineering change order implementation, and maintenance. Projects cannot properly utilize the residual time which is available after these last minute changes. Analysis has shown that, due to the dynamic nature of the various projects, the greatest number of changes normally occur five to six weeks prior to the scheduled event.

The primary objective of the DSN 8-Week Operations Planning Schedule is to assist all users of Network Resources in the refinement and development of the forthcoming 7-Day Schedule. It is published on a four-week cycle and contains current planned Network resource allocation planned for two weeks in advance of the publication date through the next sequential eight weeks.

V. Short-Range Resource Allocation Schedule

The DSN 7-Day Operations Schedule provides for the control and accountability of all activities occurring in the DSN. As an operations schedule, it contains the resources and configuration requirements necessary for minute-to-minute DSN Operations Support. The objective of the 7-Day Schedule/ Forecast are two-fold. The first and primary objective is that of providing a detailed, timed sequence of events for the operation of the Deep Space Network in the forthcoming week. The second objective is to provide all concerned parties with the latest projected tracking and support activities for the week following the published 7-Day Schedule. This Forecast provides the DSN Facilities and all other principals with the information required so that they may plan their manpower and other resource allocation in the most efficient manner. There are many factors affecting DSN resource allocation. There are those which are known and can be factored into the generation of the 7-Day Schedule; unfortunately there are also those which cannot be accurately predicted. Therefore, provision must be made for accomplishing orderly real-time changes to the published 7-Day Schedule. Real-time scheduling provides a controlled method for coordinating and documenting all real-time changes throughout the Network.

VI. Real-Time Scheduling

Changes to the published 7-Day Operations Schedule may be disruptive and counterproductive to the Network Resource Allocation System if not closely monitored and controlled. Although each originator of a change request is attempting to maximize his productive use of the Network, the sum of all inputs may be a net loss for everyone. To minimize the impact on resource allocation and maintain high network productiv-

ity, all requested changes are reviewed, assessed for impact, and closely controlled. This is accomplished by the real-time scheduling process.

Change requests to the published 7-Day Operations Schedule are submitted to DSN Scheduling for approval. Scheduling reviews each request for impact to other users, verifying concurrence when required, and availability of Network resources. When these requirements are met, the change requests are

processed. Users of Network resources should only submit these changes to ensure achievement of operational objectives.

The only changes to the published schedule that are accomplished through the Network Operations Control Team are changes required as a result of real-time activities such as spacecraft emergencies, major Network failures, resource conflict resolution, and necessary adjustment to provide committed flight support.

Table 1. User codes for the DSS Utilization Plan

Code	Activity
VKG	Viking Project and related DSN preparation testing and training activities
VK1	Viking 1 tracking pass
PNV	Pioneer Project and related DSN preparation testing and training activities
P06 P07 P08 P09 P10 P11 P12	Pioneer 06 tracking pass Pioneer 07 tracking pass Pioneer 08 tracking pass Pioneer 09 tracking pass Pioneer 10 tracking pass Pioneer 11 tracking pass Pioneer 12 tracking pass
HEL HE1	Helios Project and related DSN preparation testing and training activities Helios 01 tracking pass
VGR VG1 VG2	Voyager Project and related DSN preparation testing and training activities Voyager 1 tracking pass Voyager 2 tracking pass
R/A	Radio Astronomy: OSS, RAES, OSF and OSTA activities
A/S	Advance Systems: OSTDS activities
HRS	Host Country Radio Science - Spain or Australia
RRR	Downtime for maintenance/reconfiguration
ENG	DSN engineering support
DSN	DSN preparation testing and training activities

Table 2. DSN/FPSO station loading for weeks 9, 10, 11, and 12

Week	DSS	Total sched.	4 ± hr gaps	Maintenance	Special ^a	Conflicts
9	11	168:00	0:00	29:25	0:00	0:00
	12	168:00	0:00	168:00	0:00	0:00
	14	168:00	0:00	14:40	32:50	0:00
	42	168:00	0:00	17:45	0:00	0:00
	43	168:00	0:00	23:35	0:00	0:00
	44	168:00	0:00	20:50	0:00	0:00
	61	168:00	0:00	41:50	0:00	0:00
	62	168:00	0:00	47:55	0:00	0:00
	63	168:00	0:00	29:40	0:00	0:00
10	11	149:30	11:20	21:45	0:00	0:00
	12	168:00	0:00	168:00	0:00	0:00
	14	163:25	0:00	13:20	50:20	0:00
	42	151:00	9:25	26:00	0:00	0:00
	43	164:25	0:00	14:25	0:00	0:00
	44	163:30	0:00	19:00	0:00	0:00
	61	142:30	23:35	28:55	0:00	0:00
	62	125:00	43:00	18:50	0:00	0:00
	63	163:30	0:00	26:30	0:00	0:00
11	11	147:00	12:35	17:20	0:00	0:00
	12	168:00	0:00	168:00	0:00	0:00
	14	168:00	0:00	16:10	40:00	0:00
	42	142:00	15:25	25:30	0:00	0:00
	43	167:45	0:00	20:00	0:00	0:00
	44	161:15	0:00	21:35	0:00	0:00
	61	155:25	4:25	23:10	0:00	0:00
	62	123:15	43:00	21:15	0:00	0:00
	63	164:35	0:00	19:05	0:00	0:00
12	11	154:30	0:00	14:50	0:00	0:00
	12	168:00	0:00	168:00	0:00	0:00
	14	160:05	0:00	18:20	15:15	0:00
	42	142:05	15:05	17:30	0:00	0:00
	43	168:00	0:00	18:15	0:00	0:00
	44	153:05	0:00	16:45	0:00	0:00
	61	147:15	8:50	17:00	0:00	0:00
	62	125:30	35:05	28:50	0:00	0:00
	63	161:40	0:00	16:10	0:00	0:00

^aSpecial category consists of the following: sole plate maintenance, RTC array maintenance, and bearing maintenance.

Table 3. DSS Utilization Plan (generated 2/6/81)

Sun 15 Mar 74	HE1 VG2	RRR	R/A P11 P12	VG2	R/A P12	HE1 VG1	P11 P12	VG1	R/A P10 P12
Sat 14 Mar 73	VG1 VG2	RRR	P10 P11 P12	VG2	R/A P12	P1 1 HE1	VG2	P12 VG1	ENG P10
Fri 13 Mar 72	P12 VG1	RRR	P09 RRR	P11 P12	P10 VG2	HE1 HE1	P12 VG1	P11	P06 VG2
11 Thu 12 Mar 71	P11 P12	RRR	P10 VG2	P11 P12 P12	P10 VG2	VG1	P11	VG1	P10 P12 VG2
Wed 11 Mar 70	R/A P12 VG1 VG2	RRR	P10 P11	VG2	R/A P12	P11 HE1	P12 VG2	P12 VG1	P10
Tue 10 Mar 69	P12 HE1 VG1 VG2	RRR	P09	VG2	R/A P12	PI 1 HE1	P12 VG2	P11 P12	P10 VG1
Mon 9 Mar 68	P12 HE1 VG2	RRR	VGR VGR P11 RRR	VG1	R/A VGR P12	HE1 HE1 VG2	P12 VG1	P11 P12	VGR P10 VG2
Sun 8 Mar 67	P12 VG2	RRR	P11	P12 VG2	R/A P11	HÉ1 VG1	VG1	P11 P12	P10 P12
Sat 7 Mar 66	VG2	RRR	P10 P12	VG2	R/A P12	VG1	VG2	VG1	P11 P12
Fri 6 Mar 65	P12 HE1 VG1	RRR	P10 RRR	VG2	R/A P12	P11 HE1	P12 VG2	VG1	P09 P12 VK1
10 Thu 5 Mar 64	R/A P11 P12 HE1	RRR	RRR VG2	P11 P12 P12	R/A P10 VG2	HE1 VG1	VG2	P12 VG1	P11
Wed 4 Mar 63	P11	RRR	HE1 VG2	VG1	P12 VG2	P11 HE1	P12 VG1	P11	P10 VG2
Tue 3 Mar 62	P12 VG2	RRR	P10 RRR	P11 P12	VG2	HE1 VG1	P11	P12 VG1	P10 VG2
Mon 2 Mar 61	HE1 VG2	RRR	P12	P11 P12	R/A vG1	HE1	P12 VG2	P11	P10 P12 VG1
Sun 1 Mar 60	P12 HE1 VG2	RRR	VGR VGR R/A P10	P11 P12	VGR R/A P08 P10	HE1 VG1	VG1	R/A VG2	VGR P12
Sat 28 Feb 59	HE1 VG1	RRR	R/A P10 R/A P12	P12 VG2	P10 P12	P11 HE1	P12 VG2	P12 VG1	DSN P09
Fri 27 Feb 58	HE1 VG1	RRR	P12 HE1	P11 P12	R/A VG2	DSN P11 HE1	VG2	P12 VG1	P10 P11
9 Thu 26 Feb 57	HE1 VG2	RRR	P12 RRR	P11 P12	R/A VG2	P11 HE1	P12 VG1	P11 P12	ENG P10 VG2
Wed 25 Feb 56	P11 P12 HE1	RRR	P10 P12 VG2	P12 VG1	P12 VG2	P11 HE1	VG2	P12 VG1	P10
Tue 24 Feb 55	DSN R/A P11 P12 HE1	RRR	DSN P12 VG2	P12 VG1	P12 VG2	P11 HE1	P12 VG1	DSN P11	P10 VG2
Mon 23 Feb 54	P12 HE1 VG1	RRR	RRR	DSN P11 P12	R/A P12 VG2	HE1 VG1	DSN P11 P12	VG1	ENG P10 P12 VG2
Sun 22 Feb 53	HE1 VG1	RRR	P10 P11 P12	P12 VG2	DSN ENG R/A P12	Pi i HEi	P12 VG2	VG1	ENG DSN P06 P10
Sat 21 Feb 52	HE1 VG1	RRR	P10 P12	P12 VG2	R/A P09 P12	P11 HE1 HE1	P12 VG2	P12 VG1	P09
Fri 20 Feb 51	HE1 VG2	RRR	P10 P12	ENG P12	R/A P11	HE1 VG1	VG2	P11 P12 VG1	P10 P11
8 Thu 19 Feb 50	HE1 VG1	RRR	VGR P11 P12 RRR	ENG	VGR P12 VK1 VG2	P11 P12 HE1	P12 VG1	R/A	ENG P10 VG2
Wed 18 Feb 49	DSN P11 P12 HE1	RRR	VGR P12 VG2	ENG P12	P12 VG2	VG1	P12 VG2	DSN VG1	VGR P10
Tue 17 Feb 48	HE1 VG1	P11	P12	P12 VG2	ENG	P11 HE1. HE1	DSN P11	P12 VG1	P10 VG2
Mon 16 Feb	HE1 VG2	VG1	DSN P11 P12 RRR	DSN P11 P12 P12	P12 VG1	DSN P11	VG1	P11 P12	P10 VG2
Week Day Date Month DOY	DSS-11	DSS-12	DSS-14	DSS-42	DSS-43	DSS-44	DSS-61	DSS-62	DSS-63

Table 4. DSS Delta X-Chart (generated 2/13/81)

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		Fri	27	Feb	28					
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		Wed	52	Feb	26					
		Tue	24	Feb	25					
		Mon	23	Feb	54					
	Week	Day	Date	Month	DOY	DSS-11	DSS-12	DSS-14	DSS-42	DSS-43

Table 5. DSN 10-week operations schedule for all stations, conflicts flagged (week no. 6, 3 Feb 81 – 9 Feb 81)

(Sat. 7 Feb) 455 38 0000-2400 DSS-12 DSS-12 456 38 0025-0655 DSS-63 DSS-63 457 38 0035-0535 DSS-44 HEL-01 459 38 0535-0825 DSS-11 DSS-11 460 38 0650-1250 DSS-42 DSN-12 461 38 0650-1250 DSS-43 DSN-4 462 38 0655-1545 DSS-63 PN-12 463 38 0815-1250 DSS-43 DSS-43 464 38 0820-1745 DSS-11 VGR-01 465 38 1020-1520 DSS-61 DSS-61	no. h	Pre-track hrs-min	YOS TOS	Post-track hrs-min	DSS config	Work category	DSN	Conflict flag
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38 1020-1520 DSS-61	1255	0 30	0850-1715	0 30	610063	1A1	A000	
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REQUIRED	34-METER	106	93	39	41	39	36	49	55	35 58	3B 45	35 45	31 56	35 68	34 67	34 62	_	_	-				-		├		_
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Fig. 1. DSN forecast, Goldstone

